Testimony on Product Classification and Fluid Milk Product Definitions

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by

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Introduction

Judge Clifton and personnel of AMS Dairy Programs, I am appearing before you to offer my views and expertise on dairy markets and policy in general and dairy product classification in particular. I especially want to share relevant insights from the research my colleagues and I have done at Cornell. To the extent that my views may suggest specific policy actions, they do not represent an official statement by Cornell University.

The research about which I am testifying had its roots in a meeting that our Cornell Program on Dairy Markets and Policy (CPDMP) sponsored. In June of 2003, AMS Dairy Programs received a request for a hearing to consider changes in product definition for class I dairy products. AMS appeared ready to grant that request on very short notice. I was contacted independently by several constituents of the dairy industry and asked if CPDMP would host an informal meeting to exchange ideas and concerns regarding changes in the class I definition prior to an announcement of the hearing.

We held that meeting in Chicago on October 7, 2003. A broad cross-section of the dairy industry was invited and attended including representatives of dairy cooperatives, processors, product brokers, federal price regulators and academics. Much of the discussion from that meeting focused on the demand elasticities[1] of the dairy products in question and the need to have more information about them. After leaving the meeting, my colleagues and I felt that we had the tools to conduct research which might answer the question of "How important is it to know these elasticities with great precision?"

Today, I wish to outline the research methods and findings which I hope will be useful to you as you listen to concerns from the dairy industry. But, before I provide detailed comments, the conclusions from that research are:

> Over a broad range of market and product characteristics, the impact of reclassification of new products from class II to class I is likely to be small—less than ±0.1% of discounted revenues (±$0.01/cwt). However, if there is substitution of non-dairy ingredients for dairy ingredients (product re-formulation) in response to reclassification, the negative impacts on dairy producer revenues are much larger, about -1.8% of discounted revenues ($0.23/cwt). One way to interpret these results is that there is little upside potential from reclassification, but significant downside potential.
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> A more general implication is that a broad range of product characteristics can and should be taken into account in the classification of new dairy products. Parameter values such as demand elasticities or physical characteristics such as "form and use" are useful, but they are incomplete as guidelines for classification *if the goal is maximization of producer revenues*. Accounting for dynamic (potentially offsetting) effects will provide better insights about the outcomes of classification.

[1] Demand elasticity is the percentage change in quantity purchased divided by the percentage change in the price of the product. It is a measure of the sensitivity of buyers to price changes.

Background on Classified Pricing

The use of classified pricing for milk pre-dates the establishment of Federal Milk Marketing Orders by at least four decades. Our interpretation of the history is that producers and their organizations realized that fluid markets were able to sustain higher prices and generate higher returns to producers. Classified pricing was implemented to take advantage of this opportunity, recognizing that other product markets would receive a lower price to ensure that markets cleared. Sharing the proceeds of higher markets with producers who didn't sell to fluid processors but who conceivably could have (i.e., pooling) was necessary to avoid what has been called "destructive competition". Whether the early cooperatives knew it as such or not, they were employing a technique that economists call "price discrimination.

It is important to take note of two things in the price discrimination model. First, although producers have the ability to charge different prices to different buyers, they do not have the ability to charge whatever they please to everyone. The basic market law that supply must equal demand remains in effect: over time, a combination of prices must be found under which total production equals total consumption. Second, in order for price discrimination to result in higher net prices to producers, one set of buyers or consumers must be less price sensitive than the other set of buyers. Economists refer to this price sensitivity as the (own price) elasticity of demand.

Although there are a wide range of empirical estimates of demand elasticities for fluid milk and other dairy products there is general agreement that the demand for fluid milk is the "most inelastic" but other dairy products also have inelastic demands. Thus, charging a higher price for beverage milk will increase producer revenues, but there are offsetting consequences in the rest of the manufactured product markets. In the short run, the higher price charged for the portion of the milk supply sold to fluid processors will result in higher returns, even though sales of fluid milk will decline somewhat. The combination of reduced sales to fluid markets and the stimulus to increased milk production from higher returns means that there will be more milk that has to clear the market through sales to manufacturers.

Manufacturers, even if they have the capacity readily available, will not purchase additional milk unless they can do so at a lower price. This lower price will be necessary for them to subsequently re-price their outputs (cheese, etc) so that consumers will buy more finished dairy products. Thus, the price discrimination model requires that the higher price in one market be partially offset by a lower price in the other market, compared to what would be the price if all buyers paid the same. Because the demand for manufactured products is also inelastic, lowering the price means lower producer revenues from sales of milk to manufacturers. In this case, price discrimination results in an increase in revenues from fluid milk sales and a decrease in revenues from manufacturing milk sales. In basic theory, producers will always come out ahead, and the magnitude of the positive net effect is determined in large part by the spread between the elasticities in the two markets.

Two questions are posed in our research. First, how much gain is there for producers because of classified pricing, given conditions in today's market? And, does the answer offered by conventional theory change when one takes into account more explicitly the dynamic effects of adjustment in supply and interactions with a more complicated but also more accurate understanding of milk composition?

The Model

A dynamic model of US dairy markets with four products (two perishable products, one storable product, and a stylized "new" product) was developed to assess the extent to which new product introductions and the classification of milk used to make them influence producer revenues. Demand for the new product is assumed to grow over time, reaching its full market potential over five years. The model explicitly includes pricing for class I, class II, and a combined manufacturing class (called class III), and assumes that class III is a residual claimant on the milk supply. The inclusion of a milk supply and class III product sectors allows the model to account for dynamic effects of the new product on milk supply and classified prices. The approach used is to simulate a scenario in which there is no new product and a second "base case" scenario in which a new product with specific characteristics is introduced. We then examine the impacts on the all-milk price and cumulative discounted producer revenues compared to these two scenarios under alternative assumptions about the characteristics of new product and the classification of milk used to make it. To assess the outcomes of the classification decision, we compare scenarios in which the new product is assigned to class II for the entire simulation to scenarios that assume that the milk used for the new product is initially assigned to class II, then is switched to class I at one year into the model simulation. The difference in outcomes under these two scenarios indicates the impacts of the classification decision. The model uses the System Dynamics modeling approach, first developed and applied to business and economic research questions at the Sloan School of Management at MIT. For the model estimates, we used data from 2001 to initialize many of the model parameters.

Key characteristics of the model include[2]:

- Four products (fluid, soft, "manufacturing" and [stylized] "new product")
- Growth in demand for the new product is assumed to grow over time (assumes that the product is successful, uses an s-shaped growth curve)
- New product reaches full market potential in 5 years (takes 2.5% of previous milk supply--i.e., assumes a "big" demand)
- Explicitly includes pricing formulas for classified pricing (I, II, combined manufacturing class called "class III")
- Assumes that manufacturing is a "residual claimant" on the milk supply. (The manufacturing sector gets what's "left over" after the milk demands for I, II and the new product are satisfied. If there's more than enough milk for I, II and the new product, then manufacturing will process more)
- Uses 2001 base year data developed in detail for other modeling work
- Does not include the Dairy Price Support Program or trade policy
- Does not explicitly address the issue of divergent class III/IV prices (but could easily be modified to do so)

There are a wide variety of market factors and new product characteristics that will influence the outcomes of a new product classification decision (i.e., it's not just demand elasticity for the new product). Our model includes many of the factors that influence the outcomes of classification. More specifically, our model allows us to assess the effects of:

- Milk supply response (how much, how quickly)
- Product demand elasticities (for fluid, manufacturing and new product)
- By-products (add to the supply of milk processing in manufacturing—baseline is no by-products)
- Effects of the new product price on fluid milk sales (baseline is no effect)
- "Cannibalization" of fluid sales by the new product (baseline is none)
- Amount of milk input required for the new product (baseline is 0.5 units of milk per unit of new product)

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[2] Additional model description can be found in the proceedings from *Dairy Policy and Product Innovation—11th Annual Workshop for Dairy Economists and Policy Analysts,* April 15, 2004. Can be found at http://dairy.cornell.edu/workshops

More detailed model assumptions can be found in the appendix of this paper.

- Assumed size of the market for the new product (market potential less than 2.5% of the milk supply)
- The rate of growth in sales (full market potential reached in about five years)
- The margin over milk input costs for the new product (this indicates what proportion of the selling price is due to the milk input; it has been argued that an increase in the milk cost will have little impact on milk use or sales when the milk input value is small relative to the selling price)
- Substitution of non-milk ingredients in the formulation of the new product in response to increases in the cost due to classification (i.e., beverage manufacturers choose to use more non-dairy ingredients in response to the increase in the price of the milk input due to re-classification from I to II)

Our model assesses the impacts of classification of the new product by comparing a situation in which the product is always in class II with a situation in which the new product is initially in class II and then is switched to class I early on in the demand "growth phase". The impact of classification is the difference in key outcomes observed between these two situations (i.e., it is not comparing outcomes over time with the situation in the initial year)

Although the model generates a broad range of information, our focus is on the impacts of the classification decision on dairy producer revenues. This is a better indicator than milk price because it accounts for both the price and the quantity of milk sold. In some cases, we "discount" the value of dairy producer revenues to explicitly account for the time value of money and add them up to provide a single summary measure for comparison.

Because many of the parameter values are uncertain, we conducted a broad range of "sensitivity analyses" (making changes in parameters over some reasonable range) to assess the impact of those changes on the outcomes. In this regard, we can speak of three types of "sensitivity" to changes in parameter values: 1) numerical sensitivity--the actual numerical values change (this is almost always the case), 2) behavioral sensitivity--both the numerical values and the qualitative patterns of behavior over time change, and 3) policy sensitivity--the change in parameters changes the preferred policy (in this case the preferred policy is assumed to be one that maximizes discounted cumulative producer revenues). Our focus is on "policy sensitivity", that is, do the changes in parameter values change the decision about which class the new product should be in to maximize cumulative discounted producer revenues.

Key Model Results

New product introductions always benefit dairy farmers (increase cumulative discounted revenues) because they increase the demand for milk, (initially) reduce the milk available for manufacturing, increase manufacturing product prices, increase class III milk prices and increase the all-milk price. Over time, there is a milk supply response that will increase milk supplies, which means the milk prices will adjust over time also. In equilibrium after adjustment to the new product introduction, the all-milk price returns to a level near the original, but dairy producer revenues are higher because more milk is being sold.

Moving the new product from class II to class I early on has two possible main effects: 1) it increases the cost of making the new product, which may increase the price paid by consumers of the product, reducing product sales and therefore the milk required for making the product, and 2) it initially increases the all-milk price (compared to the situation in which the new product is left in class II) and therefore increases milk supplies (compared to the situation in which the new product is left in class II). The combination of these effects means that more milk is available to the manufacturing sector (which must use it to make product) and therefore more manufactured product is made and increases inventories, which in turn puts downward pressure on product and class III prices which rise by less than they would have if the product had remained in class II.

The effects of re-classification are offsetting: There is an initial increase in the all-milk price that arises from increasing the proportion of milk in class I, but ultimately there is an offsetting negative effect on class III markets. The net effect on dairy producer revenue depends on the relative magnitude of these two effects. In general, these effects will tend to balance each other out, and thus, the expected differences in revenue from re-classification are small. Consideration of only the short-term increase in revenues due to increasing class I utilization will overstate the impact on producer revenues of reclassification.

Over a broad range of parameter values for product demand elasticities, effects of new product price on fluid milk demand, milk supply response characteristics, milk input requirements, new product margin, mature market size, sales growth rate, by-product production and yield in manufacturing, and the assumed proportion of fluid sales "cannibalized" by the new product, the differences in cumulative discounted dairy producer revenues due to re-classification are small, ranging from a total decline of $170 million to a positive $162 million over 8 years. That is, for some scenarios reclassification increases dairy producer revenues, and in other cases re-classification decreases dairy producer revenues. These figures represent absolute-value differences of less than ±0.1% of total cumulative discounted producer revenues, or about -$0.01/cwt to +$0.01/cwt on the all-milk price over this time frame.

One parameter has a much larger impact on dairy producer revenues: the extent of substitution of non-dairy ingredients for milk in the formulation of the new product. (This is not possible for all new products, but it may be relevant for a broad range of them.) When new product manufacturers substitute non-dairy ingredients for milk rather aggressively in response to reclassification, there are significant negative impacts of the reclassification on dairy producer revenues. This negative effect is about $3.2 billion over the 9 years we simulated. This represents about -1.8% of producer revenues, or -$0.22/cwt of milk sold. This negative effect arises because the demand for milk components increases much less as demand for the new product grows over time.

Concluding Comments

Over the past year and a half, we have we have developed and refined a dynamic model of the U.S. dairy industry to specifically look at the question of new product classification. This effort has not been supported by grants from any dairy industry participants. We have viewed the inquiry from the perspective of dairy farmers and asked the question "In a dynamic and complex industry, what product classification would make milk producers better off?"

The answer to this question is that over a broad range of market and product characteristics, the impact of reclassification (moving products from class II to class I pricing) is likely to be small—less than ±0.1% of discounted revenues (±$0.01/cwt). However, if there is substitution of non-dairy ingredients for dairy components in response to reclassification, the negative impacts on dairy producer revenues are much larger, about -1.8% of discounted revenues (-$0.23/cwt). One way to interpret these results is that there is little upside potential from reclassification, but significantly important downside potential.

A more general implication is that a broad range of product characteristics can and should be taken into account in the classification of new dairy products. Parameter values such as demand elasticities or physical characteristics such as "form and use" are part of the answer, but they are incomplete as guidelines for classification if the goal is maximization of producer revenues. Accounting for dynamic (potentially offsetting) effects will provide better insights about the outcomes of classification.

Appendix

Table 1. Model Parameter Summary by Sector, Base Scenario

Parameter	Sector				
	Class I Perishable Product	Class II Perishable Product	Class III Storable Product	New Product	Input Supply
Demand Characteristics					
Reference quantity demanded, bil lbs/ month	4.68	0.82	0.77	Varies[1]	
Demand elasticity	-0.25	-0.50	-0.34	-0.50	
Reference price, $/100 lbs	32.09	142.28	154.10	29.47	
Inventory Characteristics					
Reference inventory coverage, months	[2]	[2]	2.00	1.00	
Sensitivity of price to inventory coverage	[2]	[2]	-0.50	-0.50	
Utilization Characteristics					
Capacity, bil lbs/month	[3]	[3]	1.50	Varies[1]	
Processing cost allowance, $/100 lbs	[3]	[3]	15.00	NA	
Product Yield Characteristics					
Yield, output per unit input	0.99	0.61	0.10[4]	1.00	
By product yield per unit	0.00	0.0	NA	0.00	
Demand Growth Characteristics					
Market potential, bil lbs/month	[5]	[5]	[5]	0.35	
Fractional growth rate, %/month	[5]	[5]	[5]	10.00	
Initial new quantity demanded, bil lbs/Month	[5]	[5]	[5]	0.01	
Input Supply Characteristics					
Elasticity of milk per cow w.r.t. all-milk price					0.10
Elasticity of farm capital depreciation w.r.t. increase in long-run margin over total costs					0.25
Reference all-milk price, $/100 lbs					14.93
Class differential, $/100 lbs	2.80	0.56	0.00	Varies[6]	

[1] Demand and production capacity for the new product grow over time until market saturation is reached.
[2] No inventory is assumed for perishable products.
[3] Perishable production is assumed to be equal to perishable product demand, and there is no processing cost allowance.
[4] Although the calculated yield for storable products per unit input is 0.16 and the average price is $104/cwt, the values of 0.10 and $154/cwt are used for consistency because not all storable products are included in the classified pricing formulas, as is assumed in the model structure.
[5] For simplicity, no demand growth is assumed for Class I perishable, Class II perishable or Class III storable products.
[6] Scenario-dependent value. When the NP is assigned to Class I the value is $2.80/cwt, and when assigned to Class II the value is $0.56/cwt.

Table 2. Model Parameter Values for Scenarios

Parameter	Base	Limited Long-run Supply Response	NP More Elastic, SP More Inelastic	Cross-price Elasticity = 0.025	Low Input Require -ment	Lower Milk Value Share	Faster Demand Growth
NP elasticity	-0.50	-0.50	-0.90	-0.50	-0.50	-0.50	-0.50
SP elasticity	-0.336	-0.336	-0.25	-0.336	-0.336	-0.336	-0.336
Cross-price elasticity	0.00	0.00	0.00	0.025	0.00	0.00	0.00
Short-run Supply response	0.10	0.10	0.00	0.10	0.10	0.10	0.10
Long-run supply response	0.25	0.10	0.00	0.25	0.25	0.25	0.25
NP Yield per Input	1.00	1.00	0.00	1.00	5.00	1.00	1.00
Input per unit NP	1.00	1.00	0.00	1.00	0.20	1.00	1.00
NP margin (Other Costs), $/100 lbs	15.00	15.00	0.00	15.00	15.00	30.00	15.00
Sensitivity of NP Capacity Utilization to Relative Margin	1.00	1.00	0.00	1.00	1.00	1.00	1.00
NP market size, bil lbs/month	0.3438	0.3438	0.3438	0.3438	0.3438	0.3438	0.3438
NP market growth rate, %/month	10.00	10.00	0.00	10.00	10.00	10.00	25.00
NP cannibalization fraction of Class I PP sales	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NP By-product proportion	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SP yield from NP by-product	0.10	0.10	0.00	0.10	0.10	0.10	0.10
Input substitution in NP	None	None	None	None	None	None	None

Table 2, continued

Parameter	Base	Smaller Market Potential	25% Canni-bali-zation	Large By Products and SP Yield	Input Substitution	"LeCarb"	"Swerve"
NP elasticity	-0.50	-0.50	-0.50	-0.90	-0.90	-0.50	-1.50
SP elasticity	-0.336	-0.336	-0.336	-0.336	-0.336	-0.336	-0.336
Cross-price elasticity	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Short-run Supply response	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Long-run supply response	0.25	0.25	0.25	0.25	0.25	0.25	0.25
NP Yield per Input	1.00	1.00	1.00	2.00	1.00	1.00	2.00
Input per unit NP	1.00	1.00	1.00	0.50	1.00	1.00	0.50
NP margin (Other Costs), $/100 lbs	15.00	15.00	15.00	15.00	15.00	15.00	115.00
Sensitivity of NP Capacity Utilization to Relative Margin	1.00	1.00	1.00	1.00	1.00	1.50	1.00
NP market size, bil lbs/month	0.3438	0.0859	0.3438	0.3438	0.3438	0.0343	0.0343
NP market growth rate, %/month	10.00	10.00	10.00	10.00	10.00	0.10	0.10
NP cannibalization fraction of Class I PP sales	0.00	0.00	0.25	0.00	0.00	0.10	0.00
NP By-product proportion	0.00	0.00	0.00	0.25	0.00	0.20	0.25
SP yield from NP by-product	0.10	0.10	0.10	0.25	0.10	0.25	0.25
Input substitution in NP	None	None	None	None	Yes	None	None

Note that the scenarios developed for LeCarb and Swerve use only rough estimates of the characteristics of those products, largely to illustrate how changes in <u>combinations</u> of characteristics compare to changes in <u>individual</u> characteristics.

[1] Allows substitution of non-milk ingredients in the manufacture of the new product when the ingredient cost rises above the reference value. The substitution response is assumed to be large: a 10% increase in milk cost reduces milk use in the NP by 50%, and a 15% increase in milk costs decreases milk use in the NP by 75%. This large response is for illustrative purposes only, as we have not formally explored the likely substitution response by any current milk beverage manufacturers.

Table 3. All-Milk Price and Producer Revenues with New Product Assigned to Class II, by Scenario

Scenario	First Year[1]		Second Year[2]		Last Model Year[3]	
	All-milk price[4]	Producer Revenues[5]	All-milk price[4]	Producer Revenues[5]	All-milk price[4]	Producer Revenues[5]
	$/cwt	$ million	$/cwt	$ million	$/cwt	$ million
No NP growth	14.93	24,676	14.93	24,677	14.93	24,674
Base	14.96	24,731	15.04	24,888	14.96	25,374
Difference with No New Product	0.03	55	0.11	211	0.03	700
	(Difference from Base)					
Limited long-run supply response	0.00	0	0.00	2	0.51	664
New Product Characteristics						
NP more elastic, SP more inelastic	0.00	3	0.01	23	-0.07	-91
Cross-price elasticity = 0.05	-0.01	-26	-0.02	-36	0.00	-8
Low input requirement	-0.02	-44	-0.09	-169	-0.03	-561
Low milk value share	0.00	0	0.00	1	0.00	-6
Faster demand growth	0.04	63	0.44	811	-0.15	-225
Smaller market potential	-0.02	-41	-0.09	-159	-0.03	-525
25% cannibalization	-0.01	-13	-0.03	-51	-0.01	-185
Large by-products and SP yield	-0.01	-27	-0.06	-104	-0.02	-348
Input substitution allowed	-0.01	-11	-0.03	-48	0.07	-72
"LeCarb"	-0.03	-63	-0.11	-211	-0.03	-664
"Swerve"	-0.03	-54	-0.11	-206	-0.04	-682

[1] Months 1 to 12 of model simulation.
[2] Months 13 to 24 of model simulation.
[3] Months 89 to 100 of model simulation.
[4] Quantity weighted average all-milk price during period.
[5] Sum of undiscounted producer revenues (All-milk price times quantity supplied) during period.

Table 4. Cumulative Discounted Producer Revenues with New Product Assigned to Class II, by Scenario

Scenario	Discounted Cumulative Revenues[1]	Difference from No NP Growth	% Diff from No NP	Difference from Base	% Diff from Base
	$ million	$ million	%	$ million	%
No new product	168,278				
Base	173,863	5,585	3.32%		
Limited long-run supply response	175,351	7,073	4.20%	1,488	0.86%
New Product Characteristics					
NP more elastic, SP more inelastic	173,826	5,548	3.30%	-37	-0.02%
Cross-price elasticity = 0.05	173,828	5,550	3.30%	-35	-0.02%
Low input requirement	169,381	1,103	0.66%	-4,482	-2.58%
Low milk value share	173,858	5,580	3.32%	-5	0.00%
Faster demand growth	174,860	6,583	3.91%	998	0.57%
Smaller market potential	169,663	1,385	0.82%	-4,200	-2.42%
25% Cannibalization	172,414	4,136	2.46%	-1,449	-0.83%
Large by-product and SP yield	171,081	2,803	1.67%	-2,782	-1.60%
Input substitution allowed	172,133	3,856	2.29%	-1,729	-0.99%
"LeCarb"	168,626	348	0.21%	-5,224	-3.01%
"Swerve"	168,417	139	0.08%	-5,446	-3.13%

[1] Discounted cumulative producer revenues during 100 months of model simulation. Uses a discount rate of 5% per year, or 0.4167% per month.

Table 5. Differences in Producer Revenue Indicators with New Product Assigned to Class I, by Scenario

Scenario	Second Year[1]			Last Model Year[2]				Class for max CDR[7]
	All-milk price[3]	Producer Revenues[4]	CDR[5]	All-milk price[3]	Producer Revenues[4]	CDR[5]	% CDR Diff-erence[6]	
	$/cwt	$mil	$mil	$/cwt	$mil	$mil	%	
Base	0.00	0	0	0.00	-2	-13	-0.007	I or II
Limited long-run supply response	0.00	0	0	0.00	-6	-19	-0.011	II
New Product Characteristics								
NP more elastic, SP more inelastic	0.00	-5	-3	0.00	-18	-170	-0.098	II
Cross-price elasticity = 0.05	0.02	40	33	0.00	10	162	0.093	I
Low input requirement	0.00	2	2	0.00	3	28	0.017	I
Low milk value share	0.00	5	5	0.00	7	67	0.038	I
Faster demand growth	-0.01	-13	-11	0.00	-1	-19	-0.011	II
Smaller market potential	0.00	0	0	0.00	0	0	0.000	I or II
25% Cannibalization	0.00	0	0	0.00	-3	-11	-0.006	I or II
Large by-product and SP yield	0.00	7	6	0.00	9	94	0.055	I
Input substitution allowed	-0.06	-106	-88	-0.10	-532	-3,179	-1.847	II
"LeCarb"	0.01	20	17	0.00	6	81	0.048	I
"Swerve"	0.00	1	1	0.00	1	9	0.006	I or II

[1] Months 13 to 24 of model simulation, corresponding to the first year after the assumed change in classification of milk used in the new product from Class II to Class I.

[2] Months 89 to 100 of model simulation, corresponding to seven and a half years after the change in classification.

[3] Quantity-weighted average all-milk price during period when the new product is assigned to Class I less quantity weighted average all-milk price during period when the new product is assigned to Class II

[4] Sum of undiscounted producer revenues (all-milk price times quantity supplied) during the period when the new product is assigned to Class I less sum of undiscounted producer revenues during the period when the new product is assigned to Class II.

[5] Cumulative discounted revenues as of the end of the specified period when the new product is assigned to Class I less CDR when the new product is assigned to Class II. CDR calculation uses a discount rate of 5% per year, or 0.4167% per month.

[6] Difference in CDR when the new product is assigned to Class I rather than Class II as a percentage of CDR when the new product is assigned to Class II.

[7] If the absolute percentage difference in CDR is less than 0.01%, no class preference is assigned.

Table 6. Cumulative Discounted Producer Revenues with New Product Assigned to Class that Maximizes CDR, by Scenario

Scenario	Class Used in Calculation	Discounted Cumulative Revenues[1]	Difference from No NP Growth	% Diff from No NP	Difference from Base	% Diff from Base
		$ million	$ million	%	$ million	%
No new product		168,278				
Base	II	173,863	5,585	3.32%		
Limited long-run supply response	II	175,351	7,073	4.20%	1,488	0.86%
New Product Characteristics						
NP more elastic, SP more inelastic	II	173,826	5,548	3.30%	-37	-0.02%
Cross-price elasticity = 0.05	I	173,990	5,712	3.39%	127	0.07%
Low input requirement	I	169,409	1,131	0.67%	-4,454	-2.56%
Low milk value share	I	173,925	5,647	3.36%	62	0.04%
Faster demand growth	II	174,860	6,583	3.91%	998	0.57%
Smaller market potential	II	169,663	1,385	0.82%	-4,200	-2.42%
25% Cannibalization	II	172,414	4,136	2.46%	-1,449	-0.83%
Large by-product and SP yield	I	171,174	2,897	1.72%	-2,689	-1.55%
Input substitution allowed	II	172,133	3,856	2.29%	-1,729	-0.99%
"LeCarb"	I	168,626	348	0.21%	-5,237	-3.01%
"Swerve"	I	168,426	148	0.09%	-5,437	-3.13%

[1] Discounted cumulative producer revenues during 100 months of model simulation. Uses a discount rate of 5% per year, or 0.4167% per month.

Table 7. Summary of Sensitivity Analyses and Parameter Values for which Assignment to Class I Maximizes Cumulative Producer Revenues

Parameter Modified	Base Model Value	Range of Values	Parameter Values for Which Cumulative Producer Revenues are Larger for Class I[2]
Demand Elasticities			
SP demand elasticity[1]	-0.34	-1.5 to -0.3	Nonlinear relationship with breakeven parameters decreasing in both elasticity values. (see Figure 2)
NP demand elasticity[1]	-0.5	-1.5 to -0.3	
Cross price elasticity of NP on PP	0.0	0 to 0.25	> 0.004. Difference at largest value is 1.0%.
Supply Response			
Elasticity of productivity w.r.t. markup over variable costs[1]	0.10	0.02 to 0.25	None. Nonlinear inverse relationship between breakeven parameters. Differences in CDR are greater than -0.02% over the ranges of both parameters.
Elasticity of farm capital depreciation w.r.t. decreases in long run expected markup over total costs[1]	0.25	0.05 to 0.5	
New Product Characteristics			
Input requirement for NP	0.5	0.1 to 2.0	< 0.9; nonlinear relationship. Largest difference occurs when value is 0.4 and is +0.02%
NP margin	15.0	5.0 to 100.0	> 16.1; nonlinear relationship. Difference is +0.09% at largest value.
Market size for NP, million lbs/month	343.8	85.9 to 343.8	No values for which Class I revenues larger; difference at maximum value is < -0.02%
NP sales growth rate, %/month	10	5 to 50	None. Differences in CDR are less than -0.02% over the range of parameter values.
Proportion of input to NP as by-product[1]	0.0	0.0 to 0.3	Nonlinear relationship with breakeven parameter combinations convex to origin. (see Figure 3)
Yield of SP from by-product of NP production[1]	0.0	0.0 to 0.25	
Cannibalization fraction of PP sales by NP sales	0.0	0.0 to 1.0	None. Differences in CDR are less than -0.01% over the range of parameter values.

[1] Multivariate sensitivity analysis.

[2] Note that these ranges are applicable only for the other parameters set at the values assumed in the base case. Because of the nonlinear interactions arising when multiple parameters are modified simultaneously, these ranges will also change when other parameters are modified.

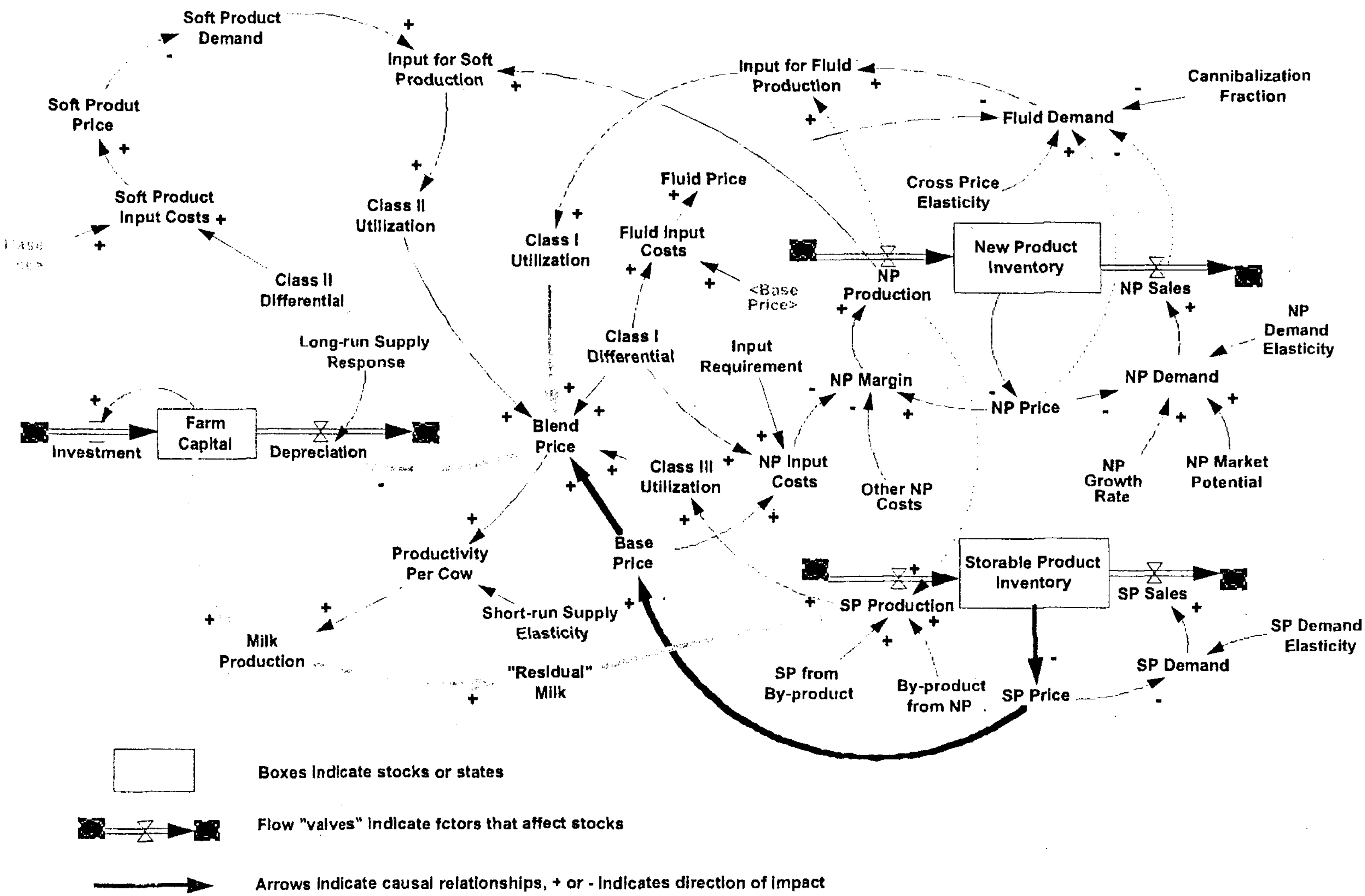

Figure 1. Simplified Structure of the Conceptual Dynamic Model, with Variables Used in Sensitivity Analyses

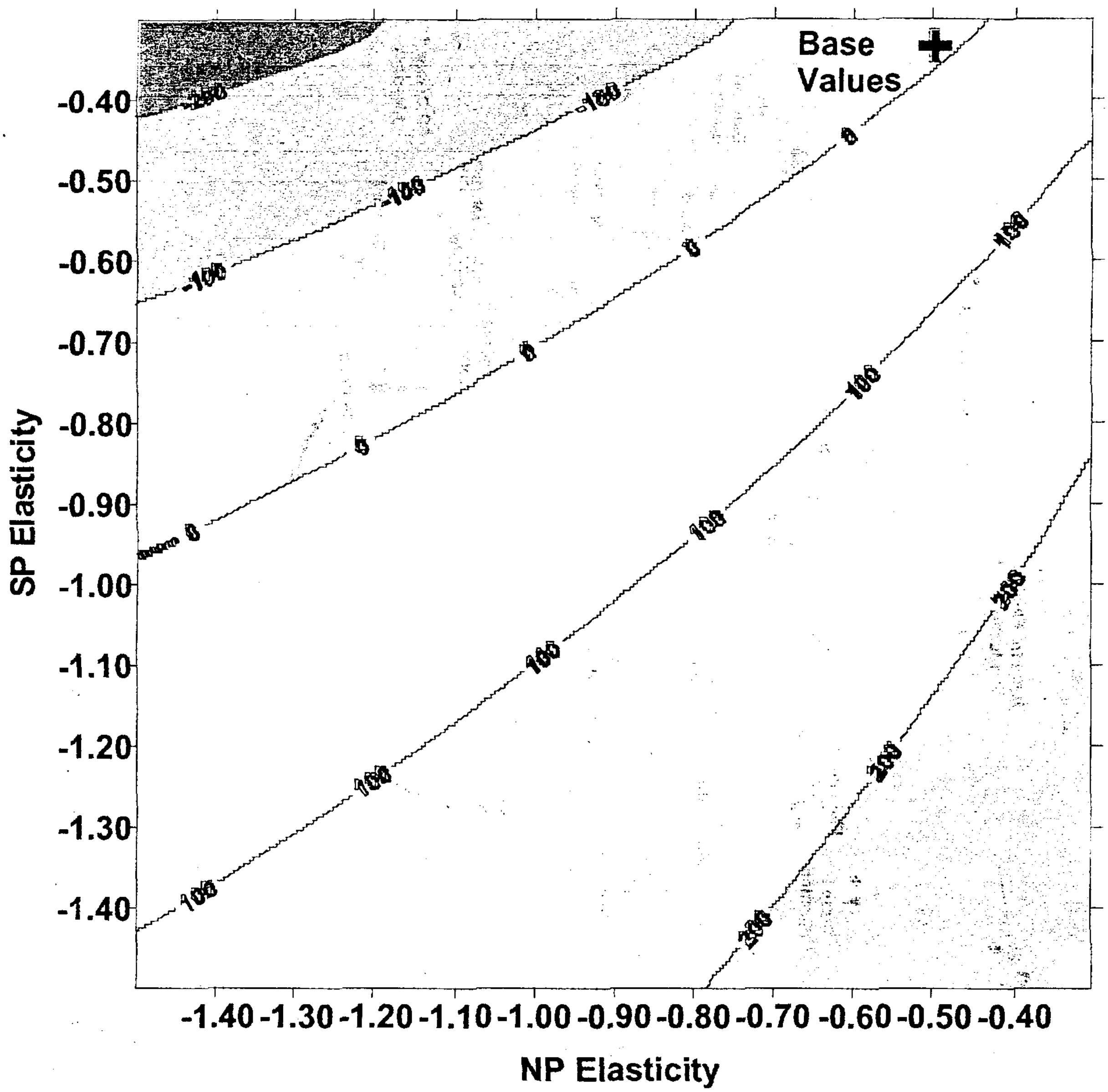

Figure 2. Difference in Cumulative Producer Revenues ($ million) with New Product Assigned to Class I, NP and SP Elasticity Combinations